

Concrete Pavement:

PCCP Repair & Rehabilitation Applications, Options & Performance

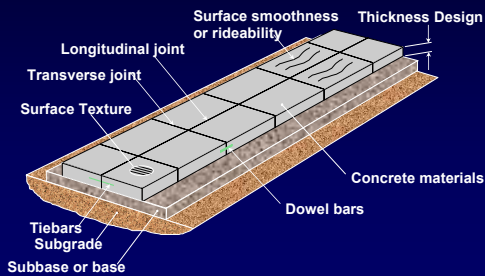
Purdue Road School

March 25, 2003



Concrete Pavement Basics

Basic Components of a Concrete Pavement

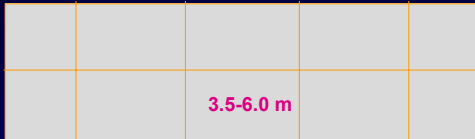


Concrete Pavement Types

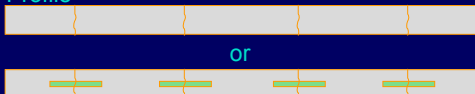
- Jointed Plain
 - Undoweled
 - Doweled
- Jointed Reinforced
- Continuously Reinforced

Jointed Plain

Plan



Profile



Jointed Plain



Jointed Plain



Jointed Plain



Load Transfer

- The slabs ability to share its load with its neighboring slab

- Dowels

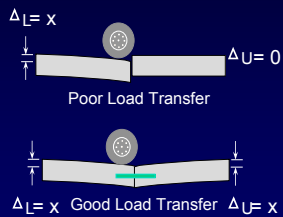
High Traffic Volumes

(Pavements > 8 in.)

- Aggregate Interlock

Low Traffic Volumes

(Pavements < 7 in.)

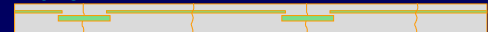


Jointed Reinforced

Plan



Profile

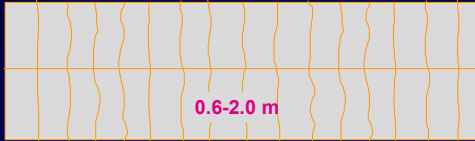


Jointed Reinforced



Continuously Reinforced

Plan



Profile

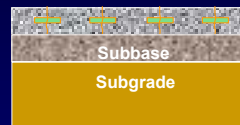


Continuously Reinforced

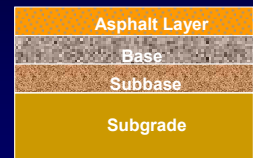


Different Pavement Types

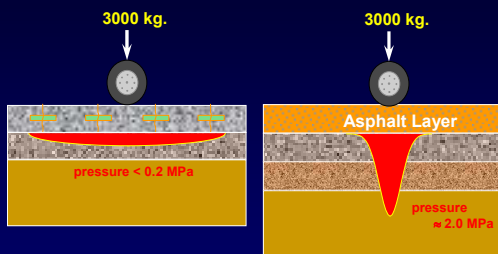
Concrete Section



Asphalt Section

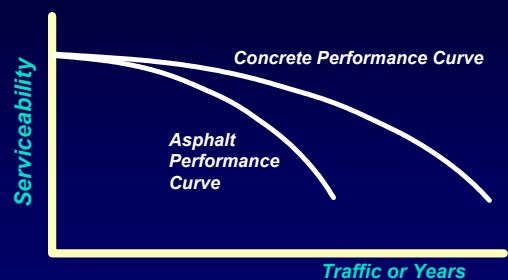


How Pavements Carry Loads

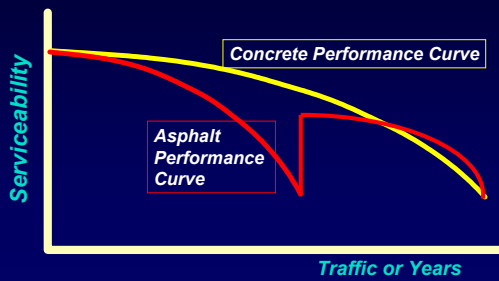


Concrete's Rigidness spreads the load over a large area and keeps pressures on the subgrade low.

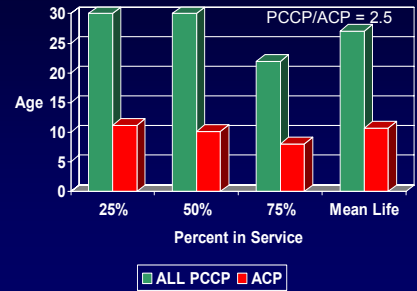
Pavement Performance



Pavement Performance



I-40 in Oklahoma Survival Analysis Results



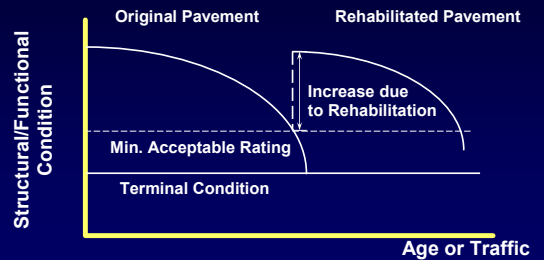
Note: Over 50% of PCCP Sections Have Not Failed (>30 Years)

Concrete Pavement Rehabilitation

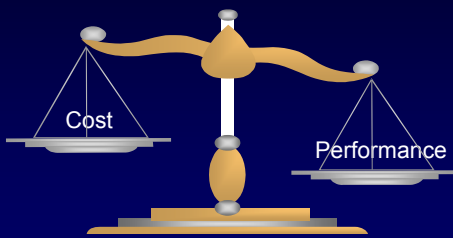
Rehabilitating Concrete
Pavements using CPR³

Restoration
Resurfacing
Reconstruction

Pavement Condition



Optimize



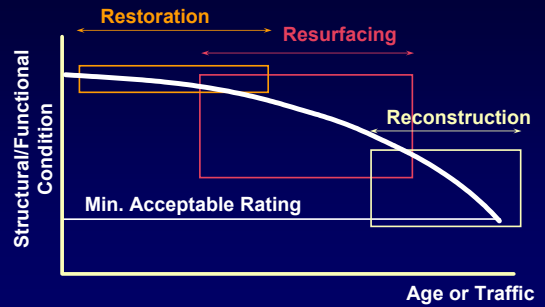
Rehabilitation Strategies

- Three categories:
 - Restoration
 - Resurfacing
 - Reconstruction
 Together, known as CPR³
- Which is used depends on existing condition.

Concrete Pavement Rehabilitation

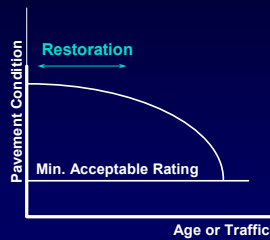
- Improves structural and/or functional condition of pavement.
 - Structural condition - the ability to carry traffic.
 - Functional condition - the ability to serve the user comfortably.

Rehabilitation Timing



Restoration (CPR)

- Used early when pavement has little deterioration.
- Repairs isolated areas of distress.



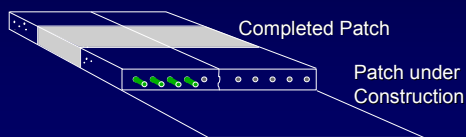
Restoration Techniques

Concrete Pavements

- Full-depth repair
- Partial-depth repair
- Diamond grinding
- Joint & crack resealing
- Slab stabilization
- Retrofitting dowels
- Retrofitting concrete shoulders
- Cross-stitching long. cracks/joints

Full Depth Repairs

- Repairs distresses greater than 1/3 the slab depth.
- Consists of removing and replacing at least a portion of the existing slab to the bottom of the concrete.



Repair Techniques

- Joint & Crack Deterioration



- Full Depth Patches

If distress greater than $\frac{1}{3} D$

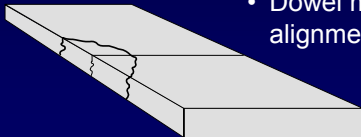


Determining Causes

- Corner Breaks



- Loss of support
 - Pumping of fines
 - Curling / Warping
- Dowel misalignment

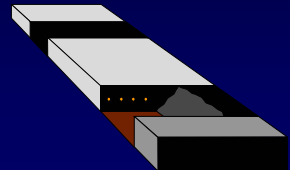


Repair Techniques

- Corner Breaks



- Full Depth Patches

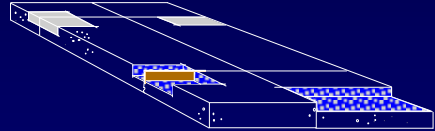


Full Depth Repair

- Consolidate concrete
- Strike off, finish & texture
- Apply curing compound & cover
- Open to traffic using INDOT chart, beam breaks or maturity meter

Partial Depth Repairs

- Repairs deterioration in the top 1/3 of the slab.
- Generally located at joints, but can be placed anywhere surface defects occur.



Carbide-Milling

Longitudinal Milling



Transverse Milling (Half-moon)



TYPICAL SPALLS



REMOVAL

- Milling machine



MILLING IN PROGRESS



TYPICAL MILLED AREA



PDR IN PROGRESS



PDR IN PROGRESS



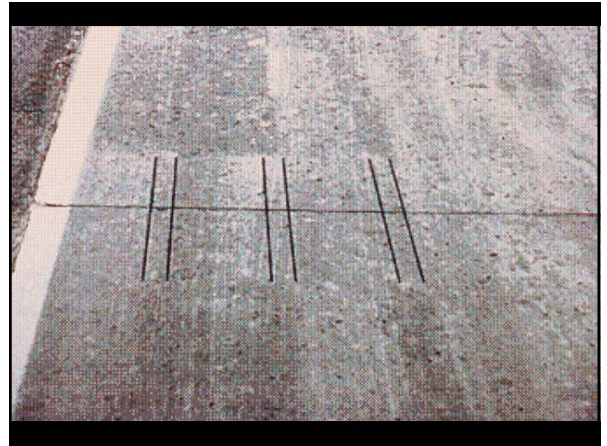
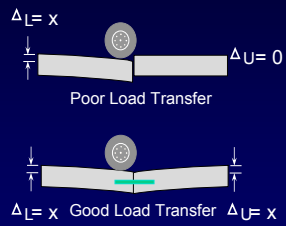
CURING

- Use curing compound



Load Transfer Restoration

- Reestablishes load-transfer at undoweled joints or cracks
- Used to limit future faulting



Concrete Pavement Restoration



Concrete Pavement Restoration



Concrete Pavement Restoration



Diamond Grinding

- Improves ride by removing:
 - Faulting at joints
 - Slab warping
 - Surface deformations caused by studded tires
- Reestablishes skid resistance
- Corrects cross-slope

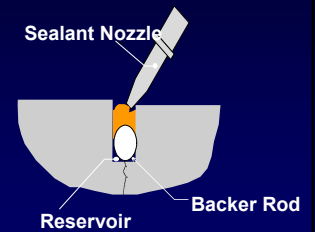


Joint and Crack Resealing

- Minimizes water & incompressibles into pavement system.

Reduces:

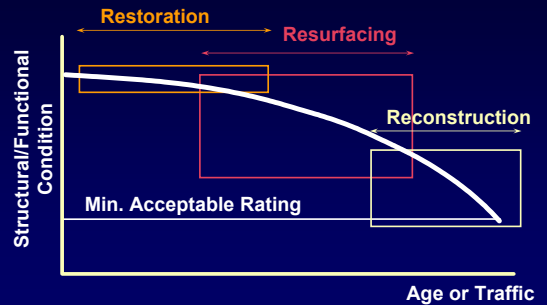
- Subgrade softening
- Pumping
- Erosion of fines
- Spalling



Restoration Performance

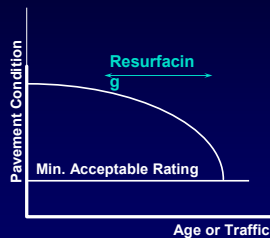
- Provides 10 or more years of service.
- Preliminary engineering & timing are critical.
- Overall effectiveness is highly dependent on design adequacy, construction quality, and other restoration activities.

Rehabilitation Timing



Resurfacing

- Used when pavement has medium to high levels of distress.
- Used when restoration is no longer effective.

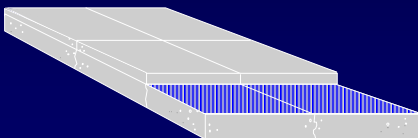


Resurfacing Activities

- Concrete overlays for concrete pavements:
 - Bonded Concrete Overlays
 - Unbonded Concrete Overlays
- Concrete overlays for asphalt pavements:
 - Conventional Whitetopping
 - Ultra-Thin Whitetopping

Bonded Overlays

- Consists of a thin concrete layer (100 mm or less) on top of an existing concrete surface.
- Specific steps are taken to bond the new concrete overlay to the existing concrete.



Bonded Overlays



Bonded Overlay

- The major use of Bonded Overlays is structural enhancement of the pavement.
- Cracks in the underlying pavement will reflect into the resurfacing
- Most often used where the underlying pavement is in reasonably good condition.

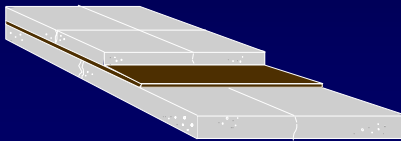
Bonded Overlays

Performance

- Good when:
 - Placed correctly and at the right time.
- Poor when:
 - Placed on deteriorated pavements.
- Loss of bond does not necessarily constitute failure.

Unbonded Overlay

- Consists of thick concrete layer (125 mm or greater) on top of an existing concrete.
- Uses a “separation interlayer” to separate new overlay and existing concrete.



Unbonded Overlays

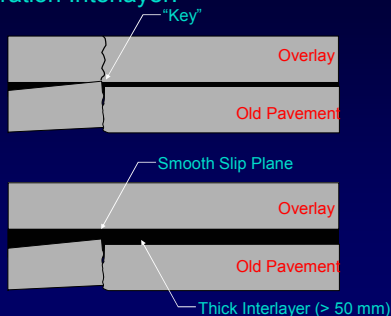
Separation Interlayer:

- Allows layers to act independently.
- Prevents distresses from reflecting into overlay.
- Typical Interlayer:
 - 1-1 ½ “ Asphalt layer



Unbonded Overlays

Separation Interlayer:



UNBONDED CONCRETE OVERLAYS

Advantages

- Can Place on Pavement in Bad Condition.
- Less Pre-Overlay Repair Needed Than Other Overlay Designs.
- No Future Reflective Cracking.
- Avoid Reconstruction Problems.
- Maintain Traffic.

UNBONDED CONCRETE OVERLAYS

Job-Site Considerations

- Overhead Structures.
- On-line Bridges.
- Shoulders.
- Fill for Slope Flattening.
- Traffic Control.

UNBONDED CONCRETE OVERLAYS

Payment

Cubic Yard



Square Yard



NOTE: Divided payment is the most equitable and economic.

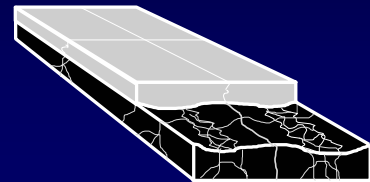
Unbonded Overlays

Performance

- Very Good
- Can be expected to perform for 20+ years.
 - Most failures are due to the use of inadequate separation layers.

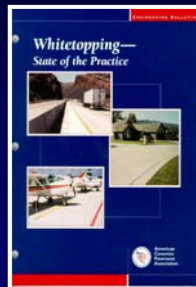
Conventional Whitetopping

- Consists of thick concrete layer (100 mm or greater) on top of an existing asphalt pavement.
- Behaves as a new pavement on a strong base.



Whitetopping Engineering Bulletin

- New for 1998
 - Conventional Whitetopping
 - Design
 - Construction
 - Performance
 - Ultra-thin Whitetopping
 - Design
 - Construction
 - Performance



Whitetopping History

- Modern usage began in Iowa in 1960's where heavy loads from farm trucks created a need for a durable pavement.
- Performance was excellent
- Over 500 miles of whitetopped roads since the 1960's
- Now used for Interstates, highways, airports, and parking lots

Typical Whitetopping Thickness

- Depends on expected traffic load.
 - City streets, county roads, and small airports
 - 100 to 175 mm (4 to 7 in.)
 - Primary roads and interstate highways
 - 175 to 280 mm (7 to 11 in.)
 - Large airports
 - 200 to 460 mm (8 to 18 in.)

Whitetopping - Advantages

Construction

- Can place on pavement in bad condition.
 - Little or no pre-overlay repair needed.
- Avoid reconstruction problems.
 - Minimal rain delays.
 - Maintain traffic on existing surface.



Whitetopping - Advantages

- Improved structural capacity.
- Maintains high level of serviceability.
- Low maintenance.
- No seasonal weakening (spring breakup).
- Concrete slabs bridge problems asphalt cannot.
- Light reflective, safe riding surface.



Whitetopping - Advantages

Long-term

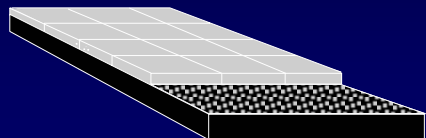
- Low maintenance.
- No seasonal weakening (spring breakup).
- No reflective cracking.
- Safe riding surface.

Whitetopping Construction

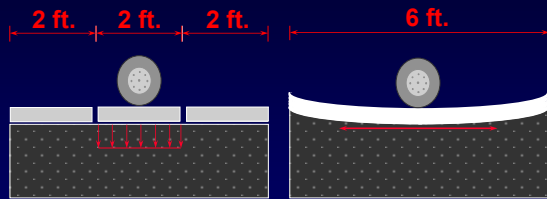
- Critical issue is uniform support
- Subgrade / base failures need repair
- Need to evaluate drainage (esp. Inlays)
- Address surface distortions
 - Direct application
 - Profile milling
 - Leveling course

Ultra-Thin Whitetopping

- Consists of thin concrete layer (4 in. or less) on top of an existing asphalt pavement.
- Specific steps are taken to bond the new concrete to the existing asphalt and to saw short joint spacing.

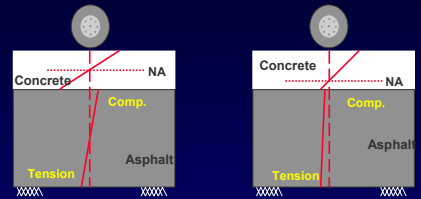


Ultra-Thin Whitetopping



Short joint spacing allows the slabs to deflect instead of bend. This reduces slab stresses to reasonable values.

Bonding Effects on Edge Stress



Unbonded	Bonded
8.49 Mpa (1230 psi)	2.90 Mpa (420 psi)

75 mm Concrete, 100 mm AC, $K=81$ Mpa/m, $E_c = 27,580$ Mpa, $E_{ac} = 2,758$ MPa

Known Design Considerations

- Bond is critical.
- Slab size (Jointing) is important.
- Underlying asphalt thickness is important.

OVERLAY PERFORMANCE in INDIANA

Specific Concrete Overlay Projects

Indiana Overlays

- I – 69 North of SR 18 – 11” 1986
- I – 65 North of SR 114 – 10.5” 1994
- I – 94 West of SR 39 – 13” 1998
- I – 70 at US 27 – Richmond – 12” 2000
- Harding Street – Indianapolis – 6” 1985
- 121st Street – Fishers – 9” 1992
- Allisonville Rd – N. of 96th – 7” 1999
- 56th Street – Brownsburg – 5” 2001

I-69 UNBONDED PCC OVERLAY

FROM SR 18 RM 66.29
to
GRANT COUNTY LINE RM 71.64

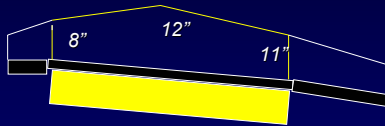
I-69 UNBONDED PCC OVERLAY

- OPENED TO TRAFFIC 1964
- RESURFACED (Bituminous) 1975
- NBL RESURFACED (Bituminous) 1978
- UNBONDED OVERLAY 1986

I-69 UNBONDED PCC OVERLAY



I-65 UNBONDED PCC OVERLAY



Harding Street - Indianapolis

- Old concrete street with patches
- PCC Unbonded overlay placed 1985
- 6" thick over old street
- Widened 6' with 8" PCCP
- Skewed non-doweled transverse joints
- Tied longitudinal joint provided at section thickness change
- Still in excellent condition

Harding Street - Indianapolis



Harding Street - Indianapolis



Harding Street - Indianapolis



121st Street - Fishers



Allisonville Road

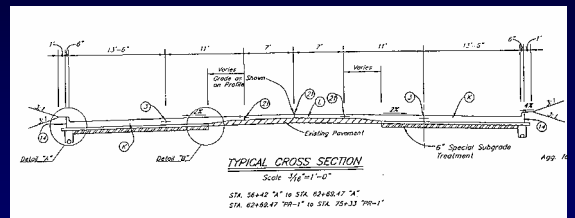
96th Street to Eller Road



Project Information

- Traffic: 26,360 vpd
- Existing 24' asphalt pavement
- Scope:
 - widen to outside
 - maintain traffic
 - mill & overlay existing

Allisonville Road Cross Section



Allisonville Road



City of Indianapolis



Ultra – thin
Whitetopping
Bus Lanes

PLACING CONCRETE



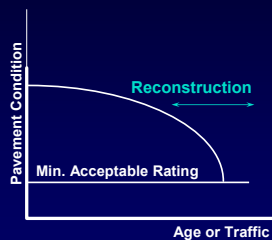
PERFORMANCE

- All three sections are performing well



Reconstruction

- Used when the pavement has high levels of distress.
- Used after overlays are no longer effective.



Reconstruction Activities

- Final stage of rehabilitation.
- Involves removing and replacing existing pavement with a new pavement.
 - Complete removal & replacement
 - Partial removal & replacement (Inlay).
- Can correct:
 - Subgrade / subbase deficiencies, Roadway geometrics, Roadside safety features, Drainage

Reconstruction Activities

- Controls the final elevation
 - Minimizes roadside appurtenances adjustments.
- Can recycle the old pavement

Summary

- CPR³ repairs structural / functional deficiencies.
- Improves pavement condition to an acceptable level.
- Appropriate activity depends on the existing pavement condition.
 - As condition declines, the optimum activity changes.
 - Applying correct activity at correct time is essential.

Summary

- Restoration
 - Repairs isolated areas of deterioration.
- Resurfacing
 - Repairs a pavement with medium to high severity levels of distress.
- Reconstruction
 - Used at the end of the pavement's life, when it has very high severity levels of distress.

Traffic Management

Maintenance of Traffic



“Don’t just do temporary repairs
but repair the road permanently”

NQI Survey

First: Dispel Myths of PCCP Construction

- Concrete takes too long
- Can not maintain traffic when building concrete pavement
- Can not build concrete pavement in high density commercial/retail corridors where must maintain access to businesses

Concrete Takes Too Long??

Concrete placed in one pass regardless of thickness



Concrete Takes Too Long??

Opening to Public Traffic



Typical opening to traffic strengths achieved in 1-3 days

Fast Track

In critical locations :
opening to traffic strength achieved in hours – not days



Opening Concrete to Traffic

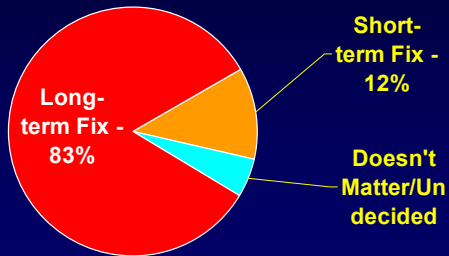
New technologies, such as Maturity Meter, provide real time strength evaluation

.....allowing opening to traffic immediately when adequate strength is achieved

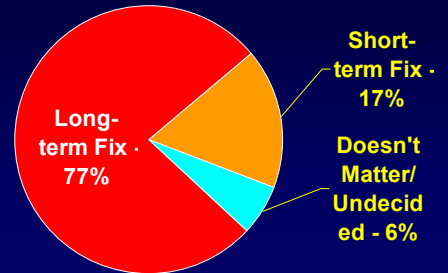
The Customer is Speaking

*Are We
Listening?*

Long-term Fix (30-35 yrs)
vs
Short-term Fix (8-10 yrs)



Long-term Fix (2-3 mo. closure)
vs
Short-term Fix (minimal closure)



Minimizing Motorist Impact

*Get In,
Do It Right,
Get Out,
Stay Out*

Questions?